

Cement MILL SECTION of Concrete

Vol. 20

JUNE, 1922

No. 6

Possibilities of Fusion Process for Cement Production

By S. L. MEYERS

During that period of the cement industry when the short rotary kiln was in vogue, many schemes were suggested and some of them tried for increasing the efficiency of the rotary kiln, but practically all of them gave way to the lengthening of the kiln. Perhaps this idea won because of its mechanical simplicity.

Owing to the large quantity of fuel consumed in the production of clinker, the efficiency of the kiln is a vital factor in the economic production of cement, and it is continually receiving the earnest attention of cement men. However, in spite of this there has been no astounding increase in the efficiency of the rotary kiln in the last few years. True, there have been improvements, and there still remains room for improvement in such matters as analysis of stack gases, use of pyrometers, superior refractories and better heat insulation, finer grinding and more uniform raw mix being fed to the kiln, regeneration of clinker and waste gas heat, exposing more clinkering surface to the flames, etc. But all of these together will not make any really drastic change.

When the efficiency of a cement kiln is compared with that of a heat engine, such as a steam engine, it compares favorably. But the maximum thermal efficiency of any heat engine is limited by the thermodynamic rule: *Maximum efficiency equals highest available temperature minus lowest available temperature, divided by the highest available temperature*, and this is exclusive of the mechanical efficiency of the engine. The burning of clinker is not limited by any such expression; it is only necessary that there be a sufficient temperature gradient between the heat supplied and the material being burned. All the heat in the universe applied to a pint of water under standard conditions will not make it boil, if the applied heat is below the boiling point of water.

Commercial portland cement clinker, like many other ceramic products, is produced by a process of sintering after the calcining stage is passed; this sintering is essentially different from the liquid fusions so common in metallurgical operations. In the present sintering process in a rotary kiln the temperature of the sintering material cannot be allowed to become high enough to have much fluid material in the mass, which would flux it and accelerate the reactions, lest rings form and the kiln become unworkable. In a fusion process the reverse of this would be true—the higher the temperature of the fluid material the better would be its working actions, and the more rapidly would it assimilate material being fed

into the fusion zone. The action of a molten mass of clinker (more properly a high lime slag) above its fusing point on a piece of calcined material, would be similar to that of hot water on a grain of sugar. Even large pieces of coarsely crushed rock would be absorbed fairly rapidly.

The universal adherence to the sintering process can be ascribed to the natural conservatism of any industry, which does not like to radically change from the methods and practice of its infancy, but mainly to the difficulties to be overcome, which will be mentioned in the order of their importance. The difficulties are: of obtaining sufficiently high temperatures, of obtaining suitable refractories, and the almost general belief that

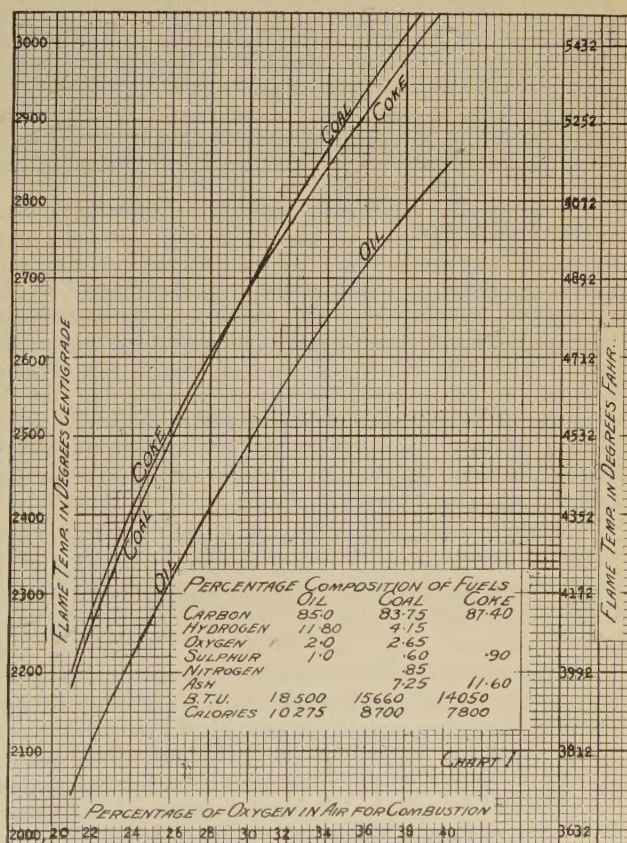


FIG. 1—THEORETICAL FLAME TEMPERATURES, WITH VARIABLE PROPORTIONS OF OXYGEN AND NITROGEN

the fusion of clinker deteriorates its quality. Let us consider these difficulties in the above order.

The theoretical flame temperature of a given fuel is that temperature at which the gases resulting from its combustion contain the same quantity of heat as that given out by the combustion of the fuel, and in special cases as that given out by the combustion of the fuel plus that added or carried in by other agencies. It will be noted that the theoretical flame temperatures of the fuels are lower than that calculated from the specific heat of gases at ordinary temperatures; this is due to an increase of heat capacity of the gases with an increase of temperatures.

The actual flame temperature of a fuel is always lower than its theoretical flame temperature. Some of the factors determining the actual flame temperature are radiation from flame, the quantity of which depends on size,

diluent nitrogen to the temperature of the flame is saved to heat the products of combustion to a still higher temperature.

Regeneration, or the abstraction of heat from the waste gases to heat the air for combustion, is in rather common use, especially in the steel and glass industries.

The use of superatmospheric pressures for increasing flame temperature has not been applied commercially as far as the writer knows. This increase of flame temperature with pressure depends upon the lower specific heat of gases at constant volume, compared with constant pressure, due to a saving of work of expansion against the atmosphere.

The electric furnace has also been considered as a possible competitor of fuel, for burning clinker in a fusion process. But only in countries like Norway, where electric power is very cheap, would it be at all economically feasible to do all of the thermal work of burning clinker. However, an electric furnace supplying the high temperature heat in combination with fuel supplying the lower temperature heat, might be possible even in this country.

The employment of high temperatures and molten materials brings up the difficult problem of selecting suitable refractories.

The following is a list of high temperature refractories, giving the melting point of the pure substance:

Alumina	2050° C. or 3722° Fah.
Chromic oxide	2060° C. " 3740° Fah.
Carborundum	2240° C. " 4060° Fah. (decomposes)
Lime	2550° C. " 4622° Fah.
Magnesia	2800° C. " 5072° Fah.
Zirconia	3000° C. " 5432° Fah.
Carbon	3700° C. " 6692° Fah. (sublimes)

It must be remembered that these are the melting points of the pure substances. The presence of impurities lowers the melting point of any substance. Further, the melting point of a refractory should be well above the temperature to which it will be subjected, in order to sustain loads and resist erosive forces. Electrically shrunk magnesia, and zirconia purer than the usual commercial article, appear to be the most favorable for combining high temperature and slag resisting qualities.

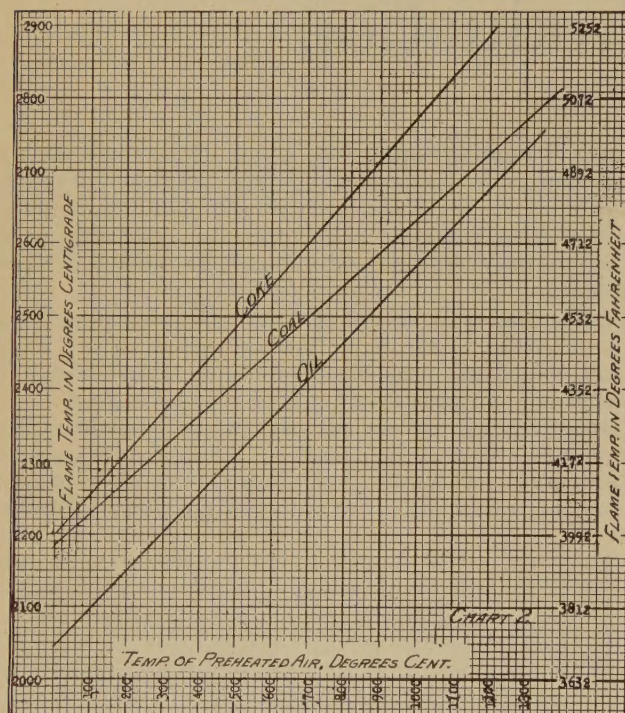


FIG. 2—EFFECT OF REGENERATION ON THE THEORETICAL FLAME TEMPERATURE

shape, temperature and emissivity of flame, also on the velocity of combustion; the amount of heat radiated back to the flame from the area inclosing the flame; the rate of doing work; the degree of completion of combustion; an excess or deficiency of combustion and the quantity of water vapor in the air for combustion; dissociation of the products of combustion and the formation of endothermic compounds. The importance of the last two increases with the temperature.

The three possible methods of raising the flame temperature of a fuel are: using oxygen enriched air for combustion, regeneration or recuperation of the air for combustion, and working the flames under superatmospheric pressure. The use of oxygen for giving high temperatures is familiar to all because of the oxyhydrogen and oxyacetylene blow torches. At present the production of oxygen and oxygen enriched air is too expensive to apply to large furnace operations. However, it is interesting to note that some iron blast furnace authorities predict its use in the blast furnace of the future. The use of oxygen enriched air to increase the flame temperature depends upon the principle that that portion of heat which would otherwise be expended to raise the

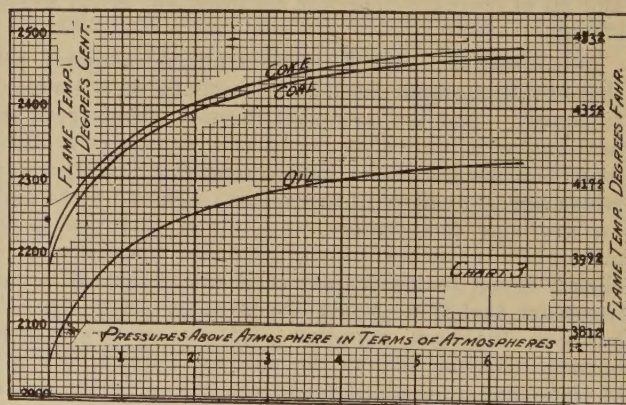


FIG. 3—THEORETICAL FLAME TEMPERATURE WORKING UNDER SUPERATMOSPHERIC PRESSURES

The refractories would have to withstand a temperature as high as that of the fused slag "clinker," which, in order to eliminate from the kiln would have to be at a free running temperature of between 1600° C. and 1700° C. This is not much higher than that employed in blast furnaces for the reduction of iron ore, and there are electric furnaces working at still higher temperatures.

The rotary kiln is more commonly in use than the vertical kiln, because a more uniform product is secured,

and less labor required, the latter being the most decisive factor. But the rotary, owing to the poor contact between combustion gases and material being burned, is far less efficient than the vertical kiln. Both the Hoffman ring furnace and the two-story vertical Dietzsch consume less than one-half the quantity of fuel per barrel that the rotary kiln does. The advantage of the rotary kiln over the vertical kiln is that the rotary kiln is capable of handling finely ground materials without preliminary nodulising or briquetting. In a fusion process the necessity for fine grinding disappears, as the feed in the form of coarsely crushed rock could be fed in at the top, descend through the ascending gases of combustion, and be absorbed by the molten fluid at the lower end of the kiln.

As the necessity for fuel economy becomes more urgent in the future, such methods as oxygen enriched air, regeneration, and the little understood use of superatmospheric pressure for increasing flame temperature, will come into more general use. Perhaps it will not be out of place here to discuss some of the advantages and disadvantages of superatmospheric pressure. Its chief disadvantage is a mechanical and structural one—the difficulty of containing it and of supplying the kiln with feed, fuel and air, and of discharging the clinkers. An advantage is that in working the gases under pressure their volume is decreased, and they are in the kiln a greater length of time. No great deductive logic is necessary to see that the heat transferring power of gases under such conditions is greatly increased. Another advantage is the possibility, or rather, since considering that power is expended in forcing air into the kiln, the necessity of utilizing the expansive force of the gases on being discharged from superatmospheric pressure to atmospheric pressure to develop power.

Assume the following conditions based on present day rotary kiln performances: One thousand barrels of clinker produced per day, using 85 lbs. of coal per barrel; the gases at the point of discharge at a temper-

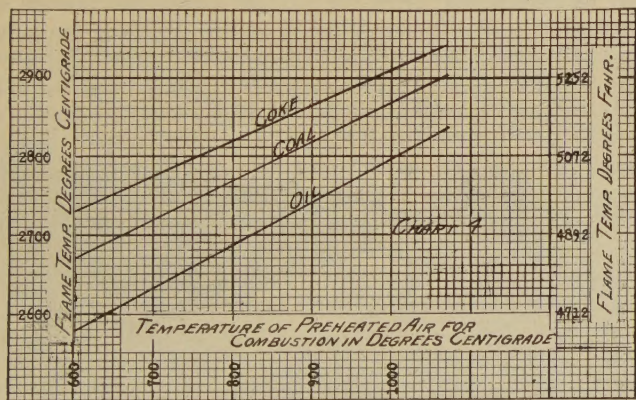


FIG. 4—THEORETICAL FLAME TEMPERATURE WITH PREHEATED AIR, THE FLAME WORKING UNDER A SUPERATMOSPHERE OF TWO

ature of 1600° Fah. And further assume the gases of combustion to be working under a superatmospheric pressure of six. The theoretical power capable of being developed from the expansion of the gases of combustion and carbon dioxide of the raw mix would be 3,490 h. p., while the power expended to force the air for combustion into the kiln would be 970 h. p., giving an ideal net gain of 2,520 h. p. Allowing for actual conditions there should still be sufficient power developed to do the total work entailed by the production of cement equivalent to the quantity of clinker under consideration. As the pressure under which a flame is worked is in-

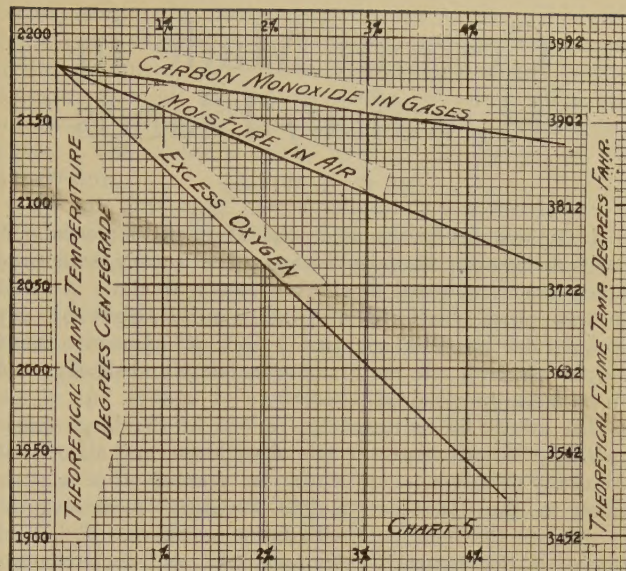


FIG. 5—THEORETICAL FLAME TEMPERATURE OF COAL, WITH EXCESS AND DEFICIENCY OF AIR; ALSO WITH MOISTURE IN AIR FOR COMBUSTION

creased, its potential capacity for developing power increases, and as the pressures increase sufficiently it is possible to have the temperature of the final discharge of the gases far below zero.

As to the almost general belief that a fused clinker is inferior to the same clinker, which has been merely sintered to the point of vitrification, there does not appear to be much experimental evidence. Several authorities conclude from theoretical considerations that a higher lime clinker would still be satisfactory if fused. The writer has fused clinkers of regular composition, and has not found any appreciable change in their properties, the tensile strength, setting time and soundness remaining the same. But in fused clinkers in which the lime was raised as high as 75%, the clinkers became unsound. (This is interesting in connection with Mr. Erdahl's experiments on unsoundness.) Of course, ordinary clinker with a lime this high would be unsound also.

It is possible that the "overburned" clinker idea may have originated in the early days of cement manufacture, when the composition of the raw mix being fed the kilns was not under such rigid control as at the present day. No doubt the fused material resulting from an improperly proportioned mix, such as a low lime, low fusing temperature one, would have poor hydraulic properties.

At very high temperatures tricalcium silicate decomposes into alpha dicalcium silicate and free lime. It is probable, though, that on slow cooling past the critical temperature the lime would recombine with the silicate, forming tricalcium again. Even if this did not occur it is a debatable question, which is the most desirable in cement, tricalcium or dicalcium silicate. In fact, for long time tests and permanence the dicalcium is preferable to the tricalcium silicate.

One thing seems certain, in a fusion process the quality of the clinker will not be as dependent on the burner as at the present time, and the less a product is dependent on the personal element the more uniform will be its quality.

Summing up, we see that although fusion process presents difficulties, they are not insurmountable, and that it does contain possibilities in fuel economy that the rotary kiln with sintering methods does not.

Cement Made in Hawaiian Islands

By C. A. WILSON

It is now ten years since the Maui Agricultural Co. started burning lime by means of a rotary kiln, and using the local coral sand as a raw material. At first it was purely experimental, with no thought of any commercial possibilities, just a sort of makeshift when shipments from the mainland were slow and ditches had to be made in a hurry.

The Maui Agricultural Co. is one of the large sugar raising plantations on the island of Maui, and all of that company's experimental work—as that of other plantations in the Hawaiian Sugar Planters' Association—accrues to the benefit of all of the members. Paia had many of the natural raw materials, and experiments were started to see if portland cement could be made. There was a shortage of silica and alumina at Paia, with an excess of iron and magnesia. But the coral sand and lava rock seemed to be ideal for the work. Typical coral sand and lava rock give the following analyses:

	Coral Sand	Lava Rock	Resulting Cement
SiO ₂	0.48	45.40	21.66
Al ₂ O ₃	1.40	20.01	5.53
Fe ₂ O ₃		17.55	6.27
CaO	50.80	9.59	59.30
MgO	3.38	4.70	4.69
SO ₃			1.15
Ignition loss	44.62	.....	1.54

As there was a need of additional silica it was supplied at first by Kieselguhr, and later quartzite was brought from the coast. The amount of silica added varied from 20 lbs. to 40 lbs. per barrel.

By the present specifications magnesia content is limited to 5.4%, and it was only by careful selection of field rock and repeated experiments that the proper requirement was met.

Alumina and iron, of course, are considered, in part, interchangeable, but there was rather too much iron for a quick setting cement. The initial set was from three to five hours and the final from six to nine hours. As a matter of fact, even at the present time in Honolulu masons tell you that there is trouble with the set. But whether that is a fact or is based on commercial jealousy, it is hard to state.

Of course, since the aim of the manufacturer was to cut out coast imports, if the cement was to be successful commercially everything must be furnished from the Islands. It was necessary to reduce the magnesia content and to test out various rocks. A mixture is now used consisting of rock quarried at Lahaina and Paia, together with the coral sand.

These two rocks give the following analysis:

	Lahaina	Paia
SiO ₂	61.98	51.74
Al ₂ O ₃	21.06	18.24
Fe ₂ O ₃	5.40	15.80
CaO	1.63	4.50
MgO	0.60	1.88
Ignition loss	1.40	4.32

The proportion runs for an average mix, 450 lbs. of coral sand to 35 lbs. of Lahaina rock and 75 lbs. of Paia per barrel. This has an initial set of one or two hours, with a final set of four to six hours, with a typical analysis of:

SiO ₂	20.86
Al ₂ O ₃	7.05

Fe ₂ O ₃	3.47
CaO	61.60
Mgo	2.99
So ₃	1.31
Ignition loss	1.90

The proportions can be varied, if necessary, to get a quick setting time of thirty minutes.

With the exception of about 2½% gypsum used to regulate the set, only materials found on Maui are used. It can easily be imagined what a saving results over the double freighting from the coast, i. e., by big steamer to Honolulu and Inter-Island steamer to Maui.

The cement they now make is a portland cement, passing all standard specifications and meeting the special tropical needs as regards setting time. It was found by experiment that in reducing the amount of inert magnesia they were able to increase the amount of lime and thus improve the strength tests.

But it is necessary, in order to pass the physical test of fineness, to find a better pebble for the tube mill which does the final grinding of the cement. These pebbles must be fairly regular in shape to keep from breaking, smooth enough to offer sufficient grinding surface, and hard enough to reduce the cement clinker to its required fineness without adding too much inert material.

In general the pebbles on Maui are too soft, and those hard ones which have been tried have not worn regular and have spalled badly. At present pebbles from Kaupo are being tried out, which may be right. If they are not, it will be necessary to transport some from the coast of Southern California, which will, of course, cut down the commercial success of the company. Danish and French pebbles are naturally out of the question.

The company has also had difficulty with the labor problem. When laborers were getting large bonuses all laborers wanted to be in the sugar industry. Working conditions in a cement mill cannot be compared with working conditions in a sugar mill, and it was hard to keep the men at work or to keep from a too large and extravagant turnover.

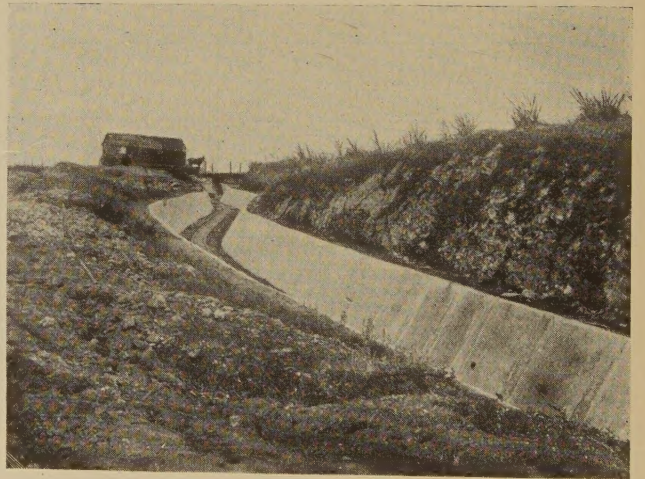


FIG. 1—ONE OF THE DITCHES ON THE MAUI AGRICULTURAL CO.'S PLANTATION—NATIVE CEMENT WAS USED IN THE LINING

The company is making much more than enough cement for its own use and that of the East Maui Irrigation Co., for ditch linings, etc., so it is able to supply the local trade and send shipments to Kauai and Oahu when occasion demands.

As soon as the more specific business needs of the various plantations are supplied, it is planned that the mill will also make enough cement to be used for housing purposes.

Grinding and Pulverizing With Air Separation¹

By S. B. KANOWITZ

RAYMOND BROTHERS IMPACT PULVERIZER CO.

The term air separation has in the past been applied to nearly every sort of apparatus which used air in handling material, and the term separator has had an equally wide application. It was applied to various air conveying systems and received its name from the fact that the collector which collected the conveyed material separated it from the conveying medium, which was air. The tendency at present is to restrict the term to an apparatus which uses air for separating and collecting the finer particles from the coarser of a ground aggregate, returning the coarser particles to the grinding equipment, or discharging them elsewhere.

The application of air separation for separating fine particles from the coarse is based on the fact that if we take a volume of dust-laden air and impart to it a rotary motion, the material will become acted upon by a centrifugal force, tending to throw the particles to the periphery in a manner similar to a dust-collector, where the material enters the collector at a tangent, receiving a cyclonic action, and thus, due to the centrifugal action produced, is thrown to the periphery and discharged, the air escaping through the top of this collector through a vent pipe, carrying some extremely fine dust with it.

If we could now collect this vent dust and also have a means of regulating the tangential or centrifugal action in the collector, so as to vary the amount passing up this vent, we would have a true air separator. This is accomplished by taking the vent of the collector and running it into a fan and blowing the air and dust into a second collector; that is, we move the fan from its original position, where it blew into the first collector, to a point where it sucks through this collector and blows into a second one. We can now close the system by running the vent from the second collector back to the intake of the first one. The first collector now becomes a separator, since its function is to separate the fines from the coarse. Each particle of dust from the separator is under the action of two forces; one, the previously mentioned centrifugal force, tending to throw it to the periphery, and the other, the central radial force produced by the suction, tending to draw the particles within the fan. Those particles on which the centrifugal force is greater than the suction force will be thrown out and the smaller particles upon which the centrifugal force is smaller than the suction force will enter the fan through the suction pipe and be blown into the collector, where they are discharged, the air returning to the separator. Let us now call the pipe running from the cyclone collector back to the separator, the intake pipe, and follow the course of material which is introduced to this intake pipe throughout the closed system.

This material, consisting of coarse and fines, after being introduced into the intake pipe is picked up by an air current and blown into the air separator. Here, as previously explained, due to the cyclonic action produced, the coarser particles are thrown out and discharged, through the bottom of the separator, while the fines enter the fan and are blown into the cyclone col-

lector, where the dust-laden air, due to the relatively large cross section of the collector, and the centrifugal action produced, is relieved of the dust, which is discharged through the bottom of the collector, while the air enters the intake pipe and continuously repeats the cycle. This gives a crude idea of the theory of air separation.

We can now show how automatic is the regulation in regard to the uniformity of the finished product. In considering what happens in the separating system when the fan tends to speed up, thus increasing the speed of the dust-laden air, we might at first think that a coarser product would be sucked into the fan and blown into the collector. But just as soon as the velocity of the air in the system is increased, the velocity of the cyclonic action within the separator is increased, which increases the centrifugal force acting on the particle, and so it is thrown out as before. A decrease in the air velocity, tending to suck over only the finer particles, will be counter-balanced by the decreased centrifugal force and the equilibrium will be again maintained. It is true that an increase in air velocity will lift up more and coarser particles in the straight pipe, but just as soon as the material enters the separator it is subjected to the separating action explained above, and so the uniformity of the material entering the fans is maintained.

We thus see that an increase in fan velocity will bring more material into the separator, increasing the capacity to some extent, but the fineness is maintained practically constant, irrespective of capacity. Of course, the velocity of the air might be so low as to seriously affect its buoyancy, so that no material gets up into the separator, but whatever material does get in is subjected to the separating action.

We thus see how inefficient an air separator would be which does not use a comparatively high air velocity with a cyclonic action, lifting up both coarse and fine and depending on the centrifugal action of rotation to throw out the over size particles. Where no cyclonic action is used, a low air velocity must be maintained so as not to lift any coarse particles, since once lifted there is no means of returning them, as there exists no actual means of separation. However, when using a low air velocity the capacity is reduced very much, as a great percentage of the fines is held within the coarse.

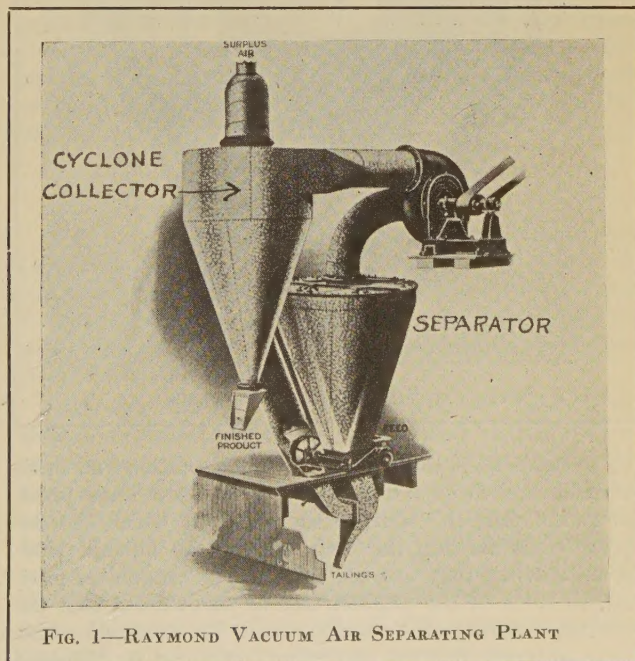


FIG. 1—RAYMOND VACUUM AIR SEPARATING PLANT

¹Abstracted from a paper presented at the National Exposition of Chemical Industries.

We now see that a high air velocity is used for separation and not for conduction. It is true that after the separation is completed enough velocity exists to convey the separated material a considerable distance and height, but this conveying is merely an incidental function of the system, adding to the general efficiency by eliminating mechanical conveyors and elevators.

In the above discussion we have merely outlined the general skeleton of an air separating system, but we did not show how the fineness of the finished product can be regulated to different degrees, which is of course desirable for most industrial applications. The separating part of an air separator in commercial use (Fig. 1) consists of a double-cone, one inside the other, with an annular space between, into which the material is introduced and also the air. The bottom of the outer cone tapers down and has at its lower extremity a valve, which discharges the tailings rejected by the air and at the same time prevents the ingress of atmospheric air.

The material as it drops into the annular space is picked up by the air and drawn within the inner cone through a series of port holes. Each port hole has a pair of veins pivoted so that they can be revolved, placing them at different angles to the periphery of the inner cone. The material entering the inner cone can be thus made to enter at an angle. When the veins are set normally to the periphery of the inner cone, that is, pointing straight towards the fan intake, no centrifugal action will be produced, and so most of the material will enter the fan, thus giving us the coarsest grade. Of course, even when there is no cyclonic action, the relatively large particles will drop out, due to the expansion of the air within the inner cone. The different angular positions of the deflector veins are indicated by a pointer on a calibrated dial on the outside of the separator. The pointer revolves with the veins. When a finer product is desired, the veins are revolved so that they sit at an angle with the periphery of the inner cone.

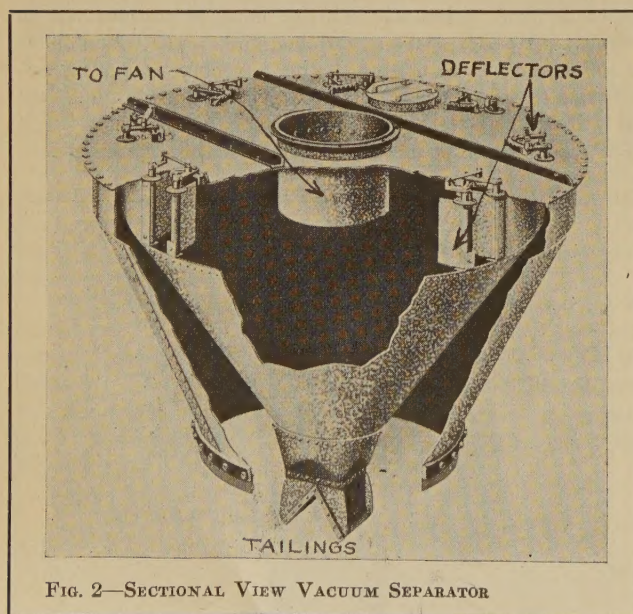


FIG. 2—SECTIONAL VIEW VACUUM SEPARATOR

The material is thus given a cyclonic motion and more particles are thrown out, which delivers a finer product to the fan; the sharper the angle at which the deflector veins are set, the finer will be the finished product until when they are set at a nearly tangential position, so much of the product will be thrown out that the material entering the cyclone will be extremely fine. These different degrees of finenesses can be obtained

by setting the pointer at the different positions on the dial and once set will maintain a uniform grade. The material rejected from the inner cone passes through a flap valve fastened to the bottom of the inner cone into the space between the two cones and is finally discharged through the flap valve on the bottom of the outer cone mentioned above. The fines are blown by the fan into the cyclone collector, where, as explained before, the material is separated from the air and discharged to bins or packing machinery, while the air returns to the separator to pick up more material and go through the same cycle.

APPLICATION TO PULVERIZING AND GRINDING EQUIPMENT

We now come to the application of air separation to pulverizing and grinding equipment. Here we must differentiate between its two main applications. In one

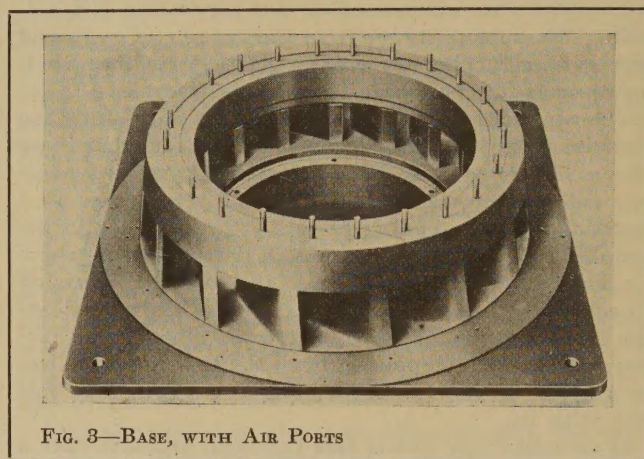


FIG. 3—BASE, WITH AIR PORTS

application the air separator is an integral part of the grinding unit, or rather, the pulverizing or grinding unit is a part of the separator. The double cone, as described above, fits right on top of the pulverizer and the return air enters underneath the grinding surface and takes away the fines with some of the coarse, just as fast as they are made, raises and passes them between the two cones, and blows them into the inner cone of the separator, where the separation of the fines from the coarse takes place in the manner described above. Fig. 3 shows the manner of the air entering underneath the grinding chamber, while Fig. 4 shows the relative position of the grinding parts and the separating parts.

The tailings from the inner cone, as will be noted from Fig. 4, drop right back to the grinding surfaces and receive further treatment. It will be noted that the air enters the grinding chamber through ports set at an angle (Fig. 3), so that material receives a rotary motion just as soon as it begins to travel up, and while in this motion the diameter of the annular space becomes larger and larger, so that the rather coarse particles keep dropping out before they enter the inner cone, where the final and complete separation takes place. The separator has thus only to handle a comparatively fine product, which increases its efficiency. The advantage of removing all fines from the grinding surface is apparent, as we all know that when we have an aggregate where the fines fill up the voids between the coarse it is nearly impossible to do any grinding. Where the separator and pulverizer form one unit they are, so to speak, self-sufficient, as no other equipment is necessary to handle the tailings, since everything is ground up and nothing passes out of the grinding chamber until it has been reduced to the proper fineness and then only through separator and cyclone. There are certain cases

Senate Considers Cement Tariff

BY IRVIN D. FOOS

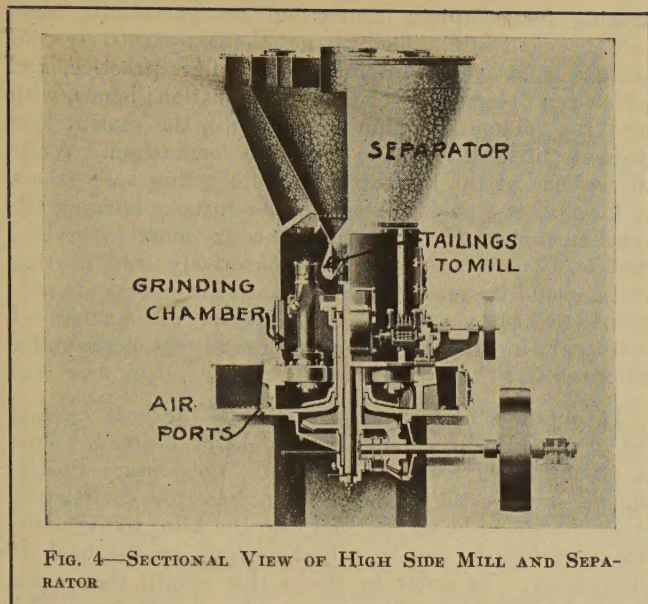


FIG. 4—SECTIONAL VIEW OF HIGH SIDE MILL AND SEPARATOR

where it is not desirable to have the tailings from the inner cone drop back to the grinding medium. In such cases a screw conveyor is inserted within the inner cone and these tailings removed.

The other application of the air separator is in conjunction with types of grinding equipment which do not have air separation as an integral part. Here the air separator is used to replace batch grinding or screens for an extremely fine product. For example: If a 200-mesh product is required, recourse was had either to batch grind, that is, using some kind of a tube mill charging it, and keeping the material in there until reduced to the requisite fineness. This in many cases is rather expensive. The other alternative was to continuously discharge from the tube mill and screen this material, which, of course, is also inefficient, as screens are not well adapted for handling an extremely fine product.

The present practice, when using a tube mill, is to feed and discharge continuously, and when a 200-mesh product is required, the material is ground so that about 60% to 70% analyzes 200 mesh. This product is then passed to the air separator, which takes out the 200-mesh particles and finer and returns the rest as tailings to be reground. I have mentioned above the use of air separators with tube mills, but any type of pulverizing and grinding equipment can be used, providing they deliver a high enough percentage of fines. It is evident from what was mentioned before that whenever possible it is advantageous to use grinding and separating equipment where the air separator is an integral part of the mill. Here we have no tailings to handle, and the efficiency of the combined unit is much higher than when an air separator is used external to the equipment. Let us consider the case of the tube mill mentioned above. After the material has traveled several feet in the tube a certain percentage of it is fine enough, but these fines have to travel all the way through the entire length of the mill before they are discharged. In the case of the mill and separator forming one unit, just as soon as the fines are formed they are removed, adding materially to the capacity. Of course, there are certain cases where it is not possible to use a combined grinding and separating unit—for example, on a very abrasive material, such as quartz and other silicious ores; then it will become more economical to use an air separator distinct from the grinding equipment.

The Senate has agreed to the Finance Committee's rate of 20% ad valorem on cement, other than portland, roman, and other hydraulic cement. The tariff bill as it passed the House provided for a duty of 17% ad valorem. On roman, portland and other hydraulic cement the Finance Committee recommended no change from the rate of 5c per 100 lbs., including weight of barrel or package; in bulk, 4c per 100 lbs., provided by the bill as it was approved by the House.

The Finance Committee included a new paragraph, which would place on crude magnesite a duty of 5/16c per lb.; caustic calcined magnesite, 5/8c per lb.; dead burned and grain magnesite not suitable for manufacture into oxychloride cements, 4/10c per lb. The bill as passed by the House fixed a duty of 3/4c per lb. on calcined magnesite, including dead burned and grain; and on magnesite, crude or ground, 1/2c per lb..

Senator Poindexter, of Washington, has announced that he will fight for the restoration of the House rate of \$15 per ton on dead burned and calcined magnesite and \$10 per ton on crude magnesite. The rates fixed by the Finance Committee were \$12.50 per ton on calcined, \$8 per ton on dead burned, and \$6.25 on crude magnesite. Senator Poindexter said that he would have the support of the new tariff bloc in the Senate. The tariff bloc numbers 25 western and southern senators, and by trading probably can fix the rates it desires.

The Finance Committee left unchanged the House schedule providing for a rate on plaster rock or gypsum, crude, of 25c per ton; ground or calcined, \$1.40 per ton; white non-staining portland cement, 8c per 100 lbs., including the weight of the container; Keene's cement and other cement of which gypsum is the component material of chief value, valued at \$14 per ton or less, \$3.50 per ton; valued above \$14 and not above \$20 per ton, \$5 per ton; valued above \$20 and not above \$40 per ton, \$10 per ton; valued above \$40 per ton, \$14.

Limestone, not suitable for use as monumental or building stone, crude, or crushed but not pulverized, will remain at 5c per 100 lbs., as provided by the House, unless the Senate changes the rate without the Finance Committee's recommendation; also lime, not specially provided for, 10c per 100 lbs., including weight of barrel or package, and hydrated lime 12c per 100 lbs., including the weight of the container.

The first large freighter to be loaded entirely with Celite products recently left Port San Luis, California, bound for Atlantic ports by way of the Panama Canal. A second freighter is now receiving its cargo, and this will be followed by still another boat also devoted exclusively to their materials.

Although the Celite Products Co. has made water shipments quite frequently in the past to the Atlantic coast, this is the first time that three entire vessels have been used to the exclusion of other cargoes. Loaded to capacity, these ships mark a departure from their established transportation method, which will undoubtedly be repeated at frequent intervals. This method enables the company to give large users the full advantage of gross shipment and decreases the transportation charge on stock maintained in Eastern warehouses.

Excess Air in Cement Kilns

By C. O. SANDSTROM

The problem of excess air in cement kilns has engrossed the attention of nearly all operators. That a large excess of air for combustion means a consequent loss is thoroughly understood, and, in the case of steam boilers, much attention is given to its exclusion. Cement kilns are, however, favored above steam boilers as ordinarily set, in that the shell is impervious to air, and the numerous points of air infiltration represented by the mortar joints, and porous brick are not present.

Air that has any direct influence on combustion enters the kiln with the fuel, through the opening leading to the cooler, through the space between the kiln and the hood and, in some cases, through openings for the purpose in the hood. The air entering the stack by way of the annular space between the kiln and stack chamber is sometimes referred to as excess air, but this is wrong, except in cases where waste heat boilers are in use. The only effect of this air is to check the draft, and this can be compensated for by an extra height of stack.

Sometimes gas temperatures are taken at the stack without regard to the effect of the air entering between kiln and stack chamber. This, of course, is liable to give a false impression unless operating conditions have been "calibrated," and the temperature readings are solely for the purpose of a check on operation.

I was once informed by the operator of a "dry" plant that his stack temperature seldom reached 600° F. A "stack" thermometer was used and this was inserted in a hole in the stack, as is common in steam boiler practice. An inspection showed that the space between kiln and stack chamber was nearly two inches; this because the end of the kiln had been burned and the eccentricity, or "wobble," required the large clearance. The effect of this clearance was minimized by my friend, but there is no escaping the fact that a space of 4 sq. ft. under a draft differential of $\frac{3}{4}$ in. of water, will admit a very large amount of air, which will have a decided effect on temperature. Of course, as stated above, this is of no consequence unless it is desired to use the waste heat.

The idea that there is present a large amount of excess air in kiln operation is sometimes caused by taking gas samples for analysis from the stack. These samples will be diluted by the air coming in around the end of the kiln, and from infiltration through the brickwork of the chamber. In order to get a representative sample it should be taken from inside the mouth of the kiln. When this is done, and the gas temperature also noted, one is in position to know whether or not the kiln is performing economically. A kiln that is really operating at the best possible efficiency may be charged with avoidable loss because of the comparatively high oxygen, and low carbon dioxide content, of the gas taken from the stack.

There has been much discussion on the subject of the correct amount of air to admit with the fuel. This air may vary from the amount just required for the effective movement of the pulverized coal, or the atomization of the oil, as the case may be, to that necessary for complete combustion. Where enough air is admitted with the fuel for its combustion, that entering from the cooler and between kiln and hood must be excess. Conditions

making for complete combustion are practically ideal in the cement kiln. There is not the comparatively cold surface that is present in steam boiler practice, and which is a deterrent to complete combustion; hence, with its large volume and high temperature, the cement kiln presents little difficulty to complete combustion. While the volume of the kiln up to the clinkering zone is not so large as is a modern steam boiler furnace burning the same amount of fuel, the conditions are more favorable; that is, the absence of the comparatively cold heating surface, and the much smaller quantity of excess air necessary to insure complete combustion. The amount of excess air in kiln operation can readily be kept under 25 per cent.

To obtain a high over-all efficiency, the heat carried out of the kiln by the clinker should be utilized. This is attempted in most plants with the rotary cooler. Should one-fourth of the air required for combustion be necessary to bring the fuel into the kiln, the remaining three-fourths can be raised to 700° by the heat of the clinker. In order to attain this result, the cooler should be provided with an air-seal and a lining. The lining may be of hard brick to resist the abrasive action of the clinker.

A fault frequently encountered in cooler installations is the failure to consider the volume of air that must pass through the opening in the firing floor and to the kiln. In the majority of installations this opening is entirely inadequate to pass the required amount of air. This is due in many cases to the construction of the hood which does not permit of a large opening.

An effort should be made to bring all the air for combustion (excepting that required for the fuel blast) through the cooler. And if this is impracticable for the reason mentioned, it would be best to bring in the additional air between the kiln and hood, as it will then be delivered in thin streams that will be more quickly brought up to the temperature of combustion than would a large volume coming in through a single large opening in the front of the hood. Should, however, the area of the opening admitting air from the cooler be sufficiently large to pass the required amount of air without the necessity of an unduly high draft pressure, then the air coming in between kiln and hood may be disregarded, because, under the low pressure, the seal angle, when closely adjusted, provides a labyrinth that offers much resistance to the flow of air.

A description of a recently constructed cement plant mentions the application of stacks in connection with the coolers. Just what necessary function is performed by these stacks is not clear. I can conceive the air passage to the kiln being so restricted that a stack would be useful in assisting to carry away the air necessary to the cooling of the clinker, but such a condition is detrimental and should be corrected, not by a stack, but by enlarging the opening.

I believe that many kilns are operated under too much draft. Of course, to get capacity there must be burned a definite amount of coal and which in turn requires a definite amount of air; this is obtained only by a definite amount of draft. But any such draft pressures as .2 and .3 inch at the hood should not be necessary. This recalls steam boiler practice, in which such draft pressures are necessary to overcome the resistance of the grates and the fuel bed. In cement kiln practice, however, the resistance to the flow of the air is the cooler, and the opening leading to the kiln. With these properly proportioned, the draft required at the hood should not exceed .1 inch.

Electric Cement

By HENRY J. HARMS, JR.
ENGINEER, COURBEVOIE, FRANCE

The new cement developed in France and concerning the manufacture of which some preliminary information has been given by the *Industrial Press*, has been the subject of two important lectures before the Franco-Belgian Association for the Testing of Materials. While the manufacturers have told very little about the manufacture, they have given some very interesting details by letter, and in interviews accorded the writer on behalf of CONCRETE. A paper was read by M. Bied, cement and lime expert, on "Le Ciment fondu au four électrique" (Cement fused in electric furnace¹), and another paper was read by Mr. Magny, civil engineer, on "Notes sur le Calcul des Pièces en béton de ciment fondu" (Notes on the Design of Electric Cement Concrete Members). With the permission of the authors I will quote freely and frequently from their papers.

Formerly I could not give a correct American name for the product, as the word "fondu" might be translated in various ways. The manufacturers must have themselves realized that the name was improper; they have now given to their cement the name of "electric cement."

The information, as given in the *Industrial Press* was not altogether correct. In fact, the new cement, or rather its *process of manufacture*, is entirely different from the one invented and manufactured by the Lafarge Co. The cement this firm manufactures, besides the ordinary portlands, is, as already stated, an "aluminous cement," manufactured by the water-jacket process, while the electric cement is produced by fusion of the raw materials in an electric furnace. From various sides tests have been made, since October, 1919, to obtain cement by fusion in electric furnaces. The main reason for these researches was the high price of coal, and therefore the desire to find cheaper methods of manufacture. After numerous failures, satisfactory results were obtained and the experimenters had the glad surprise, when testing the new cement out, to discover that it had important advantages over ordinary portland cement, and the results of the tests, apart from their practical value, were also very interesting theoretically, as they are of a nature to modify or to complete our knowledge of cements. Unfortunately, as with all industrial experiments undertaken with a definite purpose in view, some of the most interesting factors have not been controlled. In fact, although the manufacture of cement by the electric furnace process has entered the industrial stage, it is not yet scientific, as Mr. Bied writes. He explains that with scientific manufacture he means the production according to a process, all the elements of which are sufficiently well determined to permit anyone to employ same, without running any risks of failure. At present, the practitioners have the process of manufacture well in hand; cement of various qualities and compositions can be made, the necessary proportions and qualities of the raw materials are known, also voltage to be used, necessary consistency of the paste, requisite speed of cooling, etc.—in one word, all the tricks of the trade, the kinks, are known to the technicians, but

they are still proceeding more or less by intuition, and not according to well defined rules, the laws ruling the process not yet having been discovered. The manufacture of electric cement has thus not yet entered the scientific stage, and is not done according to fixed rules.

Originally the object of the tests was the production of aluminous cements of the same nature as the one manufactured by the water-jacket process. These cements fuse at about 1450° Celsius (2650° Fahr.), and should therefore be easily obtainable in the electric furnace.

The raw materials used are ferruginous bauxite and limestone.

One of the particularities of the manufacture of these cements is that one is not limited for the proportioning of the raw materials, as with portland cement. Using a bauxite containing 8% silica, 54% alumina, 15% to 20% of iron, good cements are obtained with proportions varying from 100 bauxite and 55 limestone to 100 bauxite and 140 limestone. The first mixture corresponds approximately to the composition $\text{Al}_2\text{O}_3\text{CaO}$, the second to $\text{Al}_2\text{O}_3\text{2CaO}$, (or rather, to $3\text{Al}_2\text{O}_3\text{5CaO}$) which is the composition recognized by Day. According to Spackman (American technician), one can even go much further, and reach the composition $5\text{Al}_2\text{O}_3\text{3CaO}$. The hydraulic products thus obtained are generally slow setting, with an initial set of two to four hours, and a very rapid hardening; but, in presence of traces of lime, even less than 1%, they become quick setting and absolutely unmixable.

In triturating clinkers (electric cement) in tube mills that have been used for other cements or lime, the first few tons of cement have to be rejected on account of their quick setting and slow strength. The same has happened when electric cement clinkers were treated in tube mills that had served for the crushing of carburet. Normal setting of the cement, viz., slow setting, is accompanied by a great rise of temperature. In a block of pure paste, 8 in. by 8 in., the self-registering thermometer marked 175° Celsius (347° Fahr.) shortly after the end of the setting.

Under certain conditions of calcination and of cooling, these aluminous cements are quick setting. This quick setting property has been more often observed with cements containing an overdose of limestone, and Mr. Bied queries if this might not be caused by some free non-combined lime remaining in the cement. The necessary tests to verify this hypothesis have not yet been made.

When cooling has been very slow, the setting is generally very quick, and admitting the exactitude of Leduc's tests, we might suppose that the slow cooling, similar to a re-heating, has caused lime to liberate, but it happens also that setting is quick when it is impossible to incriminate the slow cooling.

Mr. Bied asks: "Are there aluminates the setting of which is prompt?" I think we do not know anything about them, and I believe that the question of the speed of setting of a cement is still an unexplained phenomenon at the present time, and not only aluminous cements

¹As alternative translations: "Fusion cement, produced in the electric furnace," or "Electric furnace cement."

are quick setting—quick setting cements have been obtained in the rotary kiln, that contain 27% to 28% silica and only 5% alumina.

When in thin slices, electric cement shows, disseminated in a vitreous solution, greatly bi-refracting crystals that are very sensitive to polarized light; water-jacket cements show only a vitreous region, almost without any crystallization, and yet the two cements are of similar quality.

Comparing two electric furnace cements, both of the same run, and consequently of the same composition, but differing by the mode of cooling, the best one of the two showed the largest crystals (6μ for the largest and 3μ for the smallest crystals). Hendrix, in his article in *Le Ciment*, has concluded therefrom that the best cement always corresponds to the one that has the largest crystals, but Mr. Bied does not care to affirm this statement, and the question remains for him in its entirety—he points to the excellent cements obtained by the water-jacket process, that are almost without crystals.

With bauxite and limestone as raw materials, the power-consumption for the manufacture of the cement is 2,000 kilowatt hours, viz., about 1,720,000 calories (about 7,000,000 B. T. U.).

The wear of the electrodes is important. The reaction $CO_2 + C = 2CO$, very active at the high temperature of the electric furnace, causes the electrodes to use up rapidly.

The difficulty of fusion of aluminous cement lies chiefly in its low conductivity. The resistivity, as far as can be judged, is 2 million microhms per square centimeter.

Experiments have also been made with higher silica cements, but since the proportion of limestone is still higher with those cements, the power consumption is still more important and the wear of the electrodes still greater. Considered industrially, they are therefore of absolutely no interest, their cost price being absolutely prohibitive; considered from a theoretical standpoint, however, this is different, and we will therefore say a few words on the results obtained. They are better conductors than the aluminous cements, their resistivity being 500,000 microhms per square centimeter.

For these tests were used as raw materials, besides pure limestone and bauxite, a local schist of the following analysis:

SiO ₂	70
Al ₂ O ₃	17
Fe ₂ O ₃	8
CaO	5

and a blast furnace slag of the following analysis:

SiO ₂	31.86
Al ₂ O ₃	14
Fe ₂ O ₃	5.16
CaO	40
MgO	4.6

furnace, consequently in rather bad conditions of fusion and cooling.

In fact, it has been observed that there was a great difference in strengths of cements obtained in large capacity furnaces and those obtained in a small furnace. Even with a 1,500-kilowatt-hour furnace, used for the manufacture of aluminous cements, the first and second day's runs were very inferior to the one of the following days. Without changing anything in the proportions or in the conditions of calcination and cooling, the strength increased notably as the furnace came to equipose, and the technician conducting the tests gives as his opinion that absolutely normal cement is obtained only at the end of the fourth or fifth day's run.

It is therefore quite probable that the results given hereafter constitute minima, and that in practice appreciably higher strengths would be obtained.

The program of the tests was as follows:

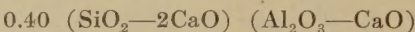
The hypothesis that the lime was always combined with the alumina in the form of mono-calcium aluminate, was taken as a starting point, and the combinations that might be made with the iron have been completely neglected.

It has been remarked that if with normal aluminous cement, the most favorable analysis of which is:

SiO ₂	10
Al ₂ O ₃	40
Fe ₂ O ₃	10
CaO	40

22 of the CaO are attributed to Al₂O₃ to form a mono-calcium aluminate, there remain 18 CaO to combine with 10 SiO₂, and the silica must consequently be in the form of bi-calcium silicate.

The cement formula would thus be:



By means of mixtures of schist, bauxite and limestone, various products have been fused, having the following composition:

0.72	(SiO ₂ —2CaO) (Al ₂ O ₃ —CaO)
1.10	(SiO ₂ —2CaO) (Al ₂ O ₃ —CaO)
1.40	(SiO ₂ —2CaO) (Al ₂ O ₃ —CaO)
1.70	(SiO ₂ —2CaO) (Al ₂ O ₃ —CaO)
1.90	(SiO ₂ —2CaO) (Al ₂ O ₃ —CaO)

All these products proved to be hydraulic. Their strengths diminish as the proportion of bi-calcium silicate increases.

The first two gave about 20 kilos at 1 day for 1:3 plastic mortar (284 lbs.). The strength has not appreciably increased with age.

The three others gave at 1 day, for 1:3 plastic mortar, from 15 to 11 kg. per sq. cms. (213 to 156 lbs. per sq. in.). These strengths have increased only slightly up to 28 days.

In diminishing the proportion of lime in order that,

TABLE I

x (SiO ₂ , 1.5CaO), y (Al ₂ O ₃ CaO)					x (SiO ₂ , 2CaO), y (Al ₂ O ₃ CaO)					x (SiO ₂ , 2.5CaO), y (Al ₂ O ₃ CaO)				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
SiO ₂	15.3	20.1	22.7	24.6	26	14.16	19.15	21.09	22.6	23.6	14.9	17.7	19.4	20.5
Al ₂ O ₃	37	31.5	27.7	25	23.2	35.78	29.11	25.81	23.10	21.2	34.3	27.7	23.7	21.1
CaO	47.3	48.4	49.6	50.6	53.8	49.26	51.74	53.10	54.30	55.10	50.8	54.6	56.9	58.3

Nos. 1, 2, 3, 4, and 5 are inert; 6, 7, 8, 9, 10 are slow setting and hydraulic; 11, 12, 13, 14, 15 are quick setting.

With these four elements: schist, slag, bauxite, and limestone, a whole series of mixtures were made, that were fused and cooled in different manners, in order to obtain cements of all sorts of analysis.

All these tests except two that could be made on a larger scale, were made with a little 20-kilowatt-hour

admitting that the lime be always combined with the alumina, in the form of mono-calcium aluminate, the silica be only combined to 1.5 of lime, the products are not hydraulic and disintegrate. If, on the contrary, the proportion of lime is increased, in order that the silica be combined with 2.5 lime, all the products are

quick-setting and the ordinary addition of gypsum does not retard the set.

Table 1 gives the developed formulas for the various products tested.

The analysis of the three series are so nearly equal that we can rightly conserve the impression that the influence of the conditions of calcination and cooling that might have varied from one experiment to the other is preponderant.

With the schist mentioned above, and limestone, a cement has been made relatively low in lime and of the following analysis:

SiO ₂	23.68
Al ₂ O ₃	4.69
Fe ₂ O ₃	2.43
CaO	61
MgO	2.10
So ₃	0.19
Humidity	4.02

The very refractory cement flowed with difficulty, even at the temperature of the arc; it was cooled by steam, which explains the humidity it contained at the moment of the analysis.

Its set was from two to four hours.
Its strength, for 1:3 plastic mortar was:

Days	1	2	3	7	28
Pounds	100	135	199	292	355

Under the polarizing microscope it showed very large, little bi-refracting tri-calcium silica crystals, of a dimension in the neighborhood of 18μ with mixtures of schist, slag and limestone, or of slag and limestone, the following cements were also obtained:

(1) SiO ₂	21.34
Al ₂ O ₃	9.30
Fe ₂ O ₃	2.78
CaO	64.05
MgO	2.21

Its strength, for 1:3 plastic mortar was:

2 days	142 lbs.
7 days	284 lbs.
28 days	398 lbs.

(2) SiO ₂	26.65
Al ₂ O ₃	6.40
Fe ₂ O ₃	2.50
CaO	57
MgO	1.86

Its strength, for 1:3 plastic mortar was:

5 days	85 lbs.
7 days	100 lbs.
28 days	171 lbs.

Setting time: 11 to 18 hours.
Given the feeble proportion of lime, these strengths are still interesting:

(3) SiO ₂	25
Al ₂ O ₃	9
Fe ₂ O ₃	4
CaO	62

Its strength, for 1:3 plastic mortar was:

7 days	71 lbs.
28 days	292 lbs.

Setting time: 10 to 17 minutes.
(4) Lastly, continuing to diminish the proportion of lime, a cement was arrived at having the composition of an acid blast furnace slag:

(4) SiO ₂	36.5
Al ₂ O ₃	8
Fe ₂ O ₃	3.5
CaO	47

This cement has given 71 lbs. at 7 days, and 100 lbs. at 28 days.

It results from all these tests that the chemical composition of cement is not at all limited between such narrow proportions as was previously believed. The series of hydraulic products is much larger. It is probably a question of crystallization at the interior of a solu-

tion, and it is this crystalization, the agent of which we must know, that we must be able to produce by an appropriate calcination and cooling. There is no doubt that similar tests give to the question of cement new aspects that may have important consequences for the future of this industry.

Although, according to Mr. Bied, the manufacture of electric cement has not yet reached the scientific stage, the manufacturers seem to have the practical process well in hand, and very interesting applications have already been made with this new product, which has decided advantages over ordinary portland cement. These advantages are:

- (1) Although slow-setting, it hardens rapidly. Roughly speaking, its strength after 24 hours equals the strength of ordinary portland cement at 28 days. This permits dismantling of floors after 24 hours, and of beams at the end of three days.
- (2) Its ultimate strength being very much greater than of portland cement, the manufacturers recommend, as a perfectly safe figure for designing, a working stress three times as high as with portland. This permits the reduction in appreciable proportions of the dimensions of beams, depths of flooring, etc.
- (3) It resists absolutely the action of sea-water and of selenetic water.

These advantages are so all-important that they more than compensate the disadvantage of the price, which is still very much higher than of ordinary first-class portland. In fact, the electric cement is actually sold at roughly 350 francs per ton of 1,000 kilos, on car at works, while the current market price for portland is 140 to 150 francs at works, for the same region.

The electric cement *cannot be used together or mixed* with other cements or lime, and great care must be taken while mixing that all utensiles, mixer, shovels, etc., have been carefully cleaned, so that no trace of cement *other than electric, or lime*, is left. After pouring, it should be kept moistened, like other cements, and a good precaution is to cover the freshly placed concrete with bags.

Earthquake at Asano Plant

The following extract from a letter recently received from Paul C. Van Zandt, chief engineer of the Asano Portland Cement Co., at Yokohama, Japan, is of interest and indicates conditions that have to be taken into consideration in Japan:

We have had the worst earthquake I have experienced in Japan this morning (April 26). The 180 ft. concrete stacks swayed like grass in a breeze, the tops moving over 6 ft. (3 ft. from plumb, both ways), but it did no damage to the plant. We stopped the machinery and made an inspection, and started up again.
It knocked all the dishes and vases from their places in my house, and broke nearly all the glassware we had, to say nothing of the lamps broken and the patches of plaster knocked from the walls. My family ran into the garden and lay down on the grass until it was all over, while down in the native village below our homes some of the little houses collapsed and killed the inmates.

Practically all the cement plants of the Lehigh region are in operation, including the reserve plants. They are well supplied with bituminous coal and, despite the strike, can remain in steady operation for some time.

There was enough bituminous coal in the Lehigh cement region on May 1 for a period of three months, according to persons engaged about the mills. Large tonnages had been received in anticipation of possible trouble in those fields.

Portland Cement in 1921

Preliminary estimates by the United States Geological Survey, given in the following table, show that the production of portland cement in 1921, 98,293,000 bbls., was more than 98% as great as that in 1920, the "record" year.

The total shipments in 1921, about 95,051,000 bbls., were nearly 99% of those in 1920.

The stock of finished cement at the mills at the end of 1921, about 11,938,000 bbls., showed an increase over the stock at the end of 1920 of more than 33%. This stock exceeded the average stock in hand at the end of each of the years 1917 to 1921 by over 27%.

The average factory price in bulk at the mills for the whole country was \$1.87 a barrel in 1921, as compared with \$2.02 a barrel in 1920, a decrease of 7.4%.

The accompanying tables show by districts the actual production, shipments, value, and stocks of portland cement for 1920, and give estimates of the same items for 1921.

PORTLAND CEMENT PRODUCED, SHIPPED, AND IN STOCK IN THE UNITED STATES IN 1921, BY DISTRICTS, AND CORRESPONDING TOTALS FOR THE UNITED STATES IN 1920 (a)

Commercial District	—Production—		—Shipments—		Value
	Quantity (bbls.)	Stock at end of year (bbls.)	Quantity (bbls.)	Av. factory price per bbl. (exclud'g cost of container)	
Lehigh district (eastern Pennsylvania and western New Jersey)	23,648,000	2,818,000	22,933,000	\$39,674,090	\$1.73
New York	5,295,000	786,000	5,040,000	9,576,000	1.90
Ohio and western Pennsylvania	9,055,000	967,000	8,819,000	15,256,870	1.73
Michigan and north-eastern Indiana	6,189,000	806,000	6,099,000	11,039,190	1.81
Illinois and remainder of Indiana	14,939,000	1,859,000	14,413,000	24,213,840	1.68
Maryland, Kentucky, Virginia, and West Virginia	4,604,000	490,000	4,482,000	8,202,060	1.83
Alabama, Tennessee, and Georgia	4,220,000	312,000	4,097,000	7,948,180	1.94
Iowa, Minnesota, and Missouri	10,519,000	1,814,000	9,959,000	17,627,430	1.77
Kansas, Nebraska, Oklahoma, and Texas	8,438,000	1,079,000	8,018,000	17,799,960	2.22
Colorado and Utah	1,865,000	204,000	1,826,000	4,254,580	2.33
California	7,073,000	502,000	6,934,000	16,294,900	2.35
Washington, Montana, and Oregon	2,448,000	351,000	2,431,000	6,101,810	2.51
1921, Total	98,293,000	11,938,000	95,051,000	177,988,910	1.87
1920, Total	100,023,245	8,941,046	96,311,719	194,439,025	2.02
Percentage of change in 1921 ..	-1.7	+33.5	-1.3	-8.5	-7.4

(a) Figures for 1921 are based to a large extent on reports of producers of portland cement, but in part on estimates, and are subject to revision.

PORTLAND CEMENT PRODUCED, SHIPPED, AND IN STOCK IN THE UNITED STATES, IN 1920, BY DISTRICTS (b)

Commercial District	—Production—		—Shipments—		Value
	Quantity (bbls.)	Stock at end of year (bbls.)	Quantity (bbls.)	Av. factory price per bbl. (exclud'g cost of container)	
Lehigh district (eastern Pennsylvania and western New Jersey)	25,417,804	2,086,370	24,953,127	\$47,875,881	\$1.92
New York	5,885,053	553,989	6,049,150	12,200,693	2.02
Ohio and western Pennsylvania	7,843,112	752,582	6,943,400	13,414,249	1.93
Michigan and north-eastern Indiana	5,379,187	727,927	4,922,329	11,892,249	2.42

Kentucky and southern Indiana	3,293,090	326,193	3,069,407	6,248,406	2.04
Illinois and western Indiana	13,106,011	1,094,358	12,321,840	22,561,398	1.83
Maryland, Virginia, and West Virginia	3,044,691	256,476	2,912,308	6,128,117	2.10
Tennessee, Alabama, and Georgia	2,888,811	191,319	2,730,420	6,010,436	2.20
Iowa, Minnesota, and Missouri	12,406,745	1,261,131	11,511,954	22,259,081	1.93
Nebraska, Kansas, Oklahoma, and central Texas	8,177,245	727,726	7,900,247	17,110,729	2.17
Rocky Mountain States (Colorado, Utah, Montana, and western Texas)	3,764,502	251,236	3,734,784	8,316,576	2.23
Pacific Coast States (California, Oregon, and Washington)	9,316,989	711,739	9,262,753	20,415,205	2.20
	100,023,245	8,941,046	96,311,719	194,439,025	2.02

(b) The state grouping differs somewhat from that given in the preceding table.

Production of Stone in 1921

About 62,400,000 short tons of stone was quarried in the United States in 1921, according to the United States Geological Survey, Department of the Interior. This is more than 20% less than the production in 1920. The estimated value of this stone is \$92,500,000, a decrease of 30% as compared with 1920.

Producers all over the country stated that both wages and prices had been reduced, and nearly all reported a decrease in the cost of production. High freight rates are said to have contributed largely to the general depression in the industry.

Building stone was in but little demand, and the returns at hand indicate a decrease in output of about 25%. The output of monumental stone, which has shown practically no diminution during the last five years, apparently decreased more than 45%. Paving blocks were in great demand, and increases were shown in the sales of curbing and flagging, facts that indicate a revival in street work in cities and towns. The campaign begun for the betterment of suburban and country roads caused an increase of nearly 8% in the output of crushed stone. Depression in the metal-smelting industry was reflected in a decrease of more than 50% in stone sold for fluxing and for use as refractory material. Decreases were noted also in the demand for agricultural limestone, and for stone used by alkali works, sugar refineries, paper mills, and in other manufacturing establishments.

Production of Calcareous Marl in 1921

The output of calcareous marl in the United States in 1921 amounted to 53,730 short tons, valued at \$183,743, according to reports made by the producers to the United States Geological Survey, Department of the Interior. The quantity decreased 45% and the value 43%, as compared with 1920. In 1921 the average value per ton was \$3.42; in 1920 it was \$3.31. Nearly all the calcareous marl sold in the United States in 1921 was used for liming the soil. Some was used as a filler in patent fertilizers. More than 63% of the total output—33,978 short tons—was produced in Virginia and was valued at \$105,821. The other producing States were California, Maryland, New York, North Carolina, Ohio, Pennsylvania, South Carolina, and West Virginia. Deposits were developed in Michigan and Wisconsin.

Portland Cement Output in April

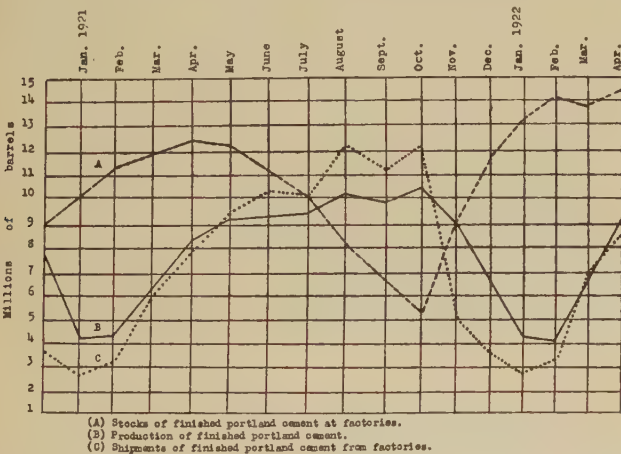
The statistics shown in the following table, prepared under the directions of G. F. Loughlin, of the United States Geological Survey, are based mainly on reports of producers of portland cement, but in part on estimates. The estimates for April were made necessary by the lack of returns from four producers.

PRODUCTION, SHIPMENTS, AND STOCKS OF FINISHED PORTLAND CEMENT IN APRIL, 1922, AND PRECEDING MONTHS

	Production (bbls.)		Shipments (bbls.)		Stocks at end of month (bbls.)	
	1921	1922	1921	1922	1921	1922
Jan.	4,098,000	a4,291,000	2,539,000	a2,981,000	10,300,000	a13,316,000
Feb.	4,379,000	4,278,000	3,331,000	2,285,000	11,400,000	a14,142,000
Mar.	6,763,000	6,685,000	6,221,000	7,002,000	12,000,000	a13,848,000
1st quar.	15,240,000	15,254,000	12,091,000	13,218,000	.....	.....
Apr.	8,651,000	9,243,000	7,919,000	8,592,000	12,600,000	14,498,000
May	9,291,000	.....	9,488,000	.....	12,450,000	.....
June	9,296,000	.....	10,577,000	.....	11,150,000	.....
2d quar.	27,228,000	.....	27,984,000	.....	.....	.....
July	9,568,000	.....	10,301,000	.....	10,414,000	.....
Aug.	10,244,000	.....	12,340,000	.....	8,280,000	.....
Sept.	10,027,000	.....	11,329,000	.....	6,953,000	.....
3d quar.	29,839,000	.....	33,970,000	.....	.....	.....
Oct.	10,506,000	.....	12,114,000	.....	5,348,000	.....
Nov.	8,921,000	.....	5,195,000	.....	9,091,000	.....
Dec.	6,559,000	.....	3,697,000	.....	11,938,000	.....
4th quar.	25,986,000	.....	21,006,000	.....	.....	.....
	98,293,000		95,051,000			

a Revised.

MONTHLY FLUCTUATIONS IN PRODUCTION, SHIPMENTS, AND STOCKS OF FINISHED PORTLAND CEMENT



The Bureau of Foreign and Domestic Commerce of the Department of Commerce reports that imports of hydraulic cement in March amounted to 1,597 bbls., valued at \$4,308. The total for 1921 was 122,317 bbls., valued at \$388,828. The imports in March were, from Mexico, 902 bbls.; France, 322 bbls.; Japan, 253 bbls.; other countries, 120 bbls.

The exports of hydraulic cement in March were 103,556 bbls., valued at \$299,977; of this total, 103,219 bbls., valued at \$298,764, was portland cement, which was sent to Cuba, 43,521 bbls.; the other West Indies, 3,763 bbls.; South America, 30,881 bbls.; Central America, 11,585 bbls.; Mexico, 10,660 bbls.; Canada, 256 bbls.; other countries, 2,553 bbls. The total exports of hydraulic cement in 1921 were 1,181,014 bbls., valued at \$4,276,986.

The statistics of imports and exports of hydraulic cement in April are not available.

Potash in 1921

More than 18,200 short tons of crude potash salts, containing 7,618 short tons of K₂O, were produced in the United States in 1921 from domestic sources, according to the United States Geological Survey, Department of the Interior. This potash was produced at 17 plants by 15 companies, and about 79.5% of it was extracted from natural brines. Three other companies produced considerable potash in 1921, but they have not yet returned their schedules. The annual production from domestic material was less in 1921 than in any other year since 1915.

Twenty-one plants made sales amounting to 8,907 short tons of crude material, containing 3,895 short tons of K₂O, valued at point of shipment at \$383,218, and 24 plants reported stocks on hand amounting to 26,461 tons of crude material containing 10,348 short tons of K₂O. Sales and stocks on hand are reported by several companies that did not produce potash in 1921.

The domestic potash produced in 1921 was made from natural brines, dusts from cement mills and blast furnaces, and wastes from molasses distilleries, and from sugar refineries that employ the Steffens process. No production has been reported from alunite, silicate rocks, kelp, or wood ashes.

The only plants that reported continuous operation during the year were several that produce potash from the dusts of cement mills and blast furnaces. The inactivity of the fertilizer market and the low price of foreign potash are given as reasons for non-production.

State Cement Plant for Arkansas

By R. S. WEST

At the recent convention of the Arkansas Chapter of the American Association of Engineers, a resolution was adopted calling on the governor to investigate the feasibility of building and operating with convict labor a state-owned cement plant at White Cliffs, in Sevier county, Arkansas.

It was stated that there is a practically inexhaustible supply of suitable raw material available at White Cliffs, in the form of shale and limestone.

The engineers stated that the prevailing price of cement was entirely out of proportion, and that this abnormal price has had the effect of retarding construction work over the state. The price of cement, it was claimed, increased more than 100% during the World War, and the drop which builders have been awaiting has not come. The average price of cement in Arkansas, including freight, was given as about \$4 a barrel, and it was claimed that the high price had discouraged use of the material to a marked degree during the past 12 months.

Some 25 years ago preparations were made to manufacture cement at White Cliffs, and some cement was placed on the market. The plant was built by a firm backed by European capital, but the plant was equipped with the old-style vertical mills, and this is believed to have been the cause of the plant's downfall.

About the time the plant got well under way, rotary kilns were introduced, greatly reducing the cost of production, and a number of the large cement plants installed these new mills. The White Cliffs plant finally gave up the fight and quit.

Men and Mills

Notes from the Field

Actual construction of the future home of the Signal Mountain Portland Cement Co. is under way. The grading and excavating for the plant site is rapidly nearing completion. The order for the structural steel to be used in the new plant was placed early in April with the firm of Walsh & Weidner. The tankage to be used in the new plant was also ordered from the Chattanooga Tank and Boiler Works. These two items are estimated at nearly \$150,000. The steel, according to the contract, is to be delivered at the plant site at Glendale as required. The building, it is stated, will be the most up-to-date of its kind in the United States. The capacity will be 5,000 bbls. daily. The plant is to be designed so that the manufacture of cement can begin with the completion of the first unit. It was stated that in all probability cement will be shipped in December of this year, or early in 1923.

George A. Campbell, office manager for the Superior Portland Cement Co., Concrete, Wash., has been elected a new member of the local school board. He is an old resident of the city. While he has never been directly connected with the administrative work of the schools, he has always taken an active interest in school and community affairs.

Among the improvements which promise a renewed period of prosperity to the Greene Co., N. Y., cement industry, the installation of a new conveyor system by the Alpha Cement Co. is important. This tramway system extends from the new steel piers to the quarries, a distance of over a mile, and will be a great convenience as well as economy in the future operations of the works. A new system of conveyors introduces the most modern methods, giving automatic service both in the crusher room and at the quarry.

The old conveyors were operated 24 hours a day in order to keep a supply of stone on hand for crushing. The new system will do the same amount of work automatically in less than eight hours. Several changes are being made in the mill, and at their completion the plant will be operated to full capacity with a full force of men, according to reports from Catskill.

C. R. Robertson, an employee of the Louisville Cement Co., completed 50 years of continuous service for that company on April 5 of this year. He started to work for the company at Speeds on April 5, 1872. His first work was in the old quarry, which is now the pond near the Brixment kilns. After working three days in the quarry he was transferred to the kilns, shoveling lime. After working at that job for 14 years he has been employed in practically every department of the mill. The last seven years he has been employed in the bag house. Mr. Robertson is now 81 years old, and on the occasion of his fiftieth anniversary with the company his picture was published in the *Speedometer*, under the heading, "Who's Who in the Louisville Cement Company."

C. S. Moyer, formerly with the Tidewater Portland Cement Co., has secured a position in the Security Cement and Lime Co.'s plant. Mr. Moyer has been a resident of Union Bridge, Md., for the past eight years.

A blast was recently set off at the quarries of the Tidewater Portland Cement Co. Fifteen holes had been sunk to a depth of 96 ft., within a space of 50 ft. by 150 ft., and loaded with dynamite aggregating a little over six tons. Many tons of rock were loosened.

Representatives of the Globe Portland Cement Co. are busy fixing up a local office in the Facade Bldg., Dubuque, Ia. The contractors who will construct the new cement plant are planning to put in the crusher plant first, and this will furnish them with their own building material, crushed stone, etc.

Paul Galgon, residing at Dewey Heights, an employee of the Whitehall Portland Cement Co., fell from the top of a crane which he was oiling at the company's quarry, and received injuries which resulted in his death. He was immediately placed in the company's ambulance and taken to the Haff Hospital, but expired before reaching the institution. Galgon had been employed on the crane for the past ten years. He is survived by his wife and several children.

Rates on cement, in carloads, from points in the Kansas gas belt and from Dewey, Okla., to points in Nebraska, South Dakota, Wyoming, Iowa and Missouri, have been found unreasonable by the Interstate Commerce Commission and the commission has ordered that reparation be awarded by the Cassville & Exeter Ry. and other carriers participating in the movement of cement under the rates in effect August 8, 1918, to and including February 28, 1920, from the cement mills of the Iola Cement Mills Traffic Association in southeastern Kansas and at Dewey, Okla., and Sunderland Brothers Co., Omaha. The Missouri Portland Cement Co., St. Louis, and the Continental Portland Cement Co. intervened in the complaint but asked no affirmative relief. The Commission found that the rates charged on the shipments which moved from Kansas producing points to destinations in Kansas were not unreasonable but that the rates charged on the shipments which moved to destinations in the states named above were unreasonable to the extent that they exceeded the rates established February 29, 1920.

A new Brixment storage house is being erected by the Louisville Cement Co. at Speeds, Ind., on the site of the old building destroyed by fire. An old warehouse is being converted into a Brixment packing house, a coat of stucco, which has been applied to the outside, making the building look like new. A cement roof has also been laid on the building.

The Interstate Commerce Commission has suspended until August 29 proposed reductions in rates on cement contained in schedules published by the Central Railroad of New Jersey, Delaware, Lackawanna & Western Railroad, Lehigh & New England Railroad, Philadelphia & Reading Railway, and Lehigh Valley Railroad.

The suspended schedules propose a reduction from 10 cents to 7 cents per 100 lbs. in the rate on cement (carloads) from cement producing points in Pennsylvania and New Jersey to New Jersey tidewater terminals, applicable on shipments destined beyond by water to points in the lighterage limits of New York harbor.

John Ball, superintendent of the West Coplay plant of the Lehigh Portland Cement Co., with the remarkable record of no lost time accidents from May 25, 1921, to March 27, 1922, gave a safety talk which inspired every one present at the district safety meeting recently, held under the auspices of the Association Bureau of Accident Prevention and Insurance.

The annual convention of the National Lime Association will be held June 14-16, Hotel Statler, Cleveland, Ohio. The activities of this convention will deal with the technology of the uses of lime, and the industrial problems of manufacturing and marketing lime.

C. O. Sandstrom, W. W. Wheeler, and R. C. Clark have opened offices in the Interstate Building, Kansas City, Mo., and will engage in the practice of engineering and construction under the name of Industrial Service Company.

Particular attention will be given to the design, construction and operation of cement, lime, brick, power, stone crushing and ice and refrigeration plants.

The service will include valuations and reports and the design and installation of machinery and mechanical equipment.

The Hudson Valley Portland Cement Corporation, which owns the property formerly operated by the Alsen's American Portland Cement Works, has put out a new issue of \$1,000,000 8% first mortgage sinking fund gold bonds, dated December 15, 1921. The money derived from the sale of the bonds will be expended for new equipment and reconstruction of the plant.

The Eighth National Exposition of Chemical Industries will be held this year in the Grand Central Palace, New York City, during the week of September 11-16, inclusive. It will follow immediately upon the fall meeting of the American Chemical Society. "Raw materials, machinery, products" is the way the exposition is described, and is intended to carry this main impression. The raw materials are exhibits of the natural resources from out of the earth and above the earth. The machinery exhibits consist of apparatus and equipment and instruments for control, precision, recording, gauging, measuring, and machinery for every mechanical operation in the manufacture of products from the raw materials. The products themselves are the finished products and the exhibits will contain those of organic and inorganic origin, of solid, liquid, or gaseous form, and of every conceivable nature.

The Standard Portland Cement Co.'s plant at Napa Junction, Cal., will not be dismantled, but will be kept intact in order that as soon as business conditions permit it might again resume operations on the same extensive scale as in former years. Although some of the machinery has been removed to Santa Cruz, for use at the plant of the Santa Cruz Portland Cement Co., which owns the Napa Junction plant, the main equipment has been left undisturbed and will remain ready to begin operations at short notice. Residents in the vicinity of the Napa Junction plant are hopeful that the plant will soon be going full blast again.

Stockholders of the Liberty Potash Co., which concern has been in the hands of the Bankers Trust Co., Salt Lake City, Utah, as receivers, have been endeavoring to find a purchaser for the property, but to date have been unsuccessful. The courts have directed the receiver to sell the property either at public or private sale to satisfy the claims against it.

Two new lime briefs have just been issued by the National Lime Association, Washington, D. C.

Lime Brief 251 is the first publication of its kind undertaking to summarize completely all of the uses of lime, and to present that summary on a functional basis, grouping together under various headings the uses that depend on the same chemical function.

The publication covers the agricultural, chemical, and construction fields, and is arranged in such a way as to be useful to the lime producer, chemical manufacturers and the educational institution. Included in the brief is a comprehensive chart giving a bird's-eye view of the entire subject.

Lime Brief 265 presents an outline of the fundamentals in the textile industry, with particular attention to the processes involving the use of lime. The brief also gives specifications for the kind of lime that should be used in the textile industry and closes with a summary of the various merits of lime.

The report of the British Portland Cement Co. for 1921 shows that the company did not do so well last year as in 1920. Profits, however, were on a comparatively satisfactory level. The dividend is being reduced from 15% to 10%, as is shown in the subjoined comparison of the figures for the two years:

	1921	1920
	£	£
Net profits	369,212	478,406
Brought forward	181,478	136,265
Preference dividend	550,690	614,671
Ordinary dividend	70,800	70,800
	188,262	207,393
	(10%)	(15%)
General depreciation	150,000	150,000
Barge depreciation	5,000	5,000
Carried forward	186,628	181,478

The directors report a steady decline in the demand for portland cement during the past year. So far as the trade was concerned, they mention three reasons for the lessened demand—the coal strike, general trade depression, and the change of policy with regard to national housing schemes. Foreign exchange difficulties and lower freights from the Continent were the chief causes for the falling off in the export demand.

Alabama cement mills are being operated at capacity, while orders are coming from the states of Georgia, Mississippi, Louisiana, Florida, the Carolinas, and Tennessee. Orders for 25,000 bbls. of cement have just been received for the Government hospital to be built at Tuskegee, Ala.

Among Alabama cement makers there is not much concern over the report that 2,500,000 bbls. of Swedish cement is to be imported into this country, according to dispatches from Charlotte, N. C., by the Southern Power Co. and the North Carolina Highway Commission. The Southern Power Co. alone wants 250,000 bbls. of cement this year, and has work under construction calling for 750,000 bbls. These reports state that Swedish cement will be handled at Wilmington, N. C., at an estimated saving of \$250,000 owing to the difference in price. But Alabama mills have already booked orders for a large quantity of cement for North Carolina highways, and do not regard the Swedish importation proposal feasible.

Liner Advertisement

FIRST CLASS MANAGER wanted immediately for large, new wet process rotary kiln cement plant in India nearing completion. First class salary will be paid to the right man, preferably one having had varied cement works experience. Reply, giving references. Maxted & Knott, Ltd., Consulting and Cement Engineers, Burnett Ave. and High Street, Hull, England.

Caterpillars for Railroad-Type Shovels

The Bucyrus Company of South Milwaukee, Wisconsin, has recently announced that it is prepared to equip all sizes of railroad-type shovels with caterpillar traction, making economies of operation possible.

This installation may be made on all sizes of railroad-type shovels up to the heaviest now built.

The principal advantages of mounting a shovel of this type on caterpillars are summarized by the Bucyrus company as follows:

- No time lost in moving up.
- An ordinary move requires about 10 seconds only.
- No rails to lay.
- No jacks to release and set.
- No stops during operation to reset jacks.
- The shovel is always ready to dig.
- The shovel does not have to face blasting.
- May be moved back and out of the way quickly and easily.
- Can be turned around quickly.
- No track trouble when in water.
- In emergencies, such as slides, can be moved back quickly out of danger.

Shovel can always dig at most effective distance from bank; short moves easy and quick to make.

No delay on account of boulders rolling in close to shovel.

Lighter work for pitmen.

Saves from two to four pitmen and sometimes more.

Can travel and work on approximately same character of ground as shovel on railroad trucks.

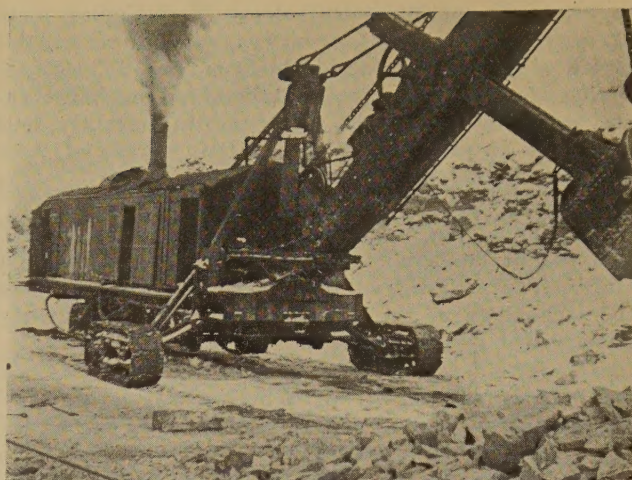
Where shovel on railroad trucks requires blocking under jacks and both rails, when working on soft ground, the shovel on caterpillars requires blocking only under the caterpillars.

This mounting consists in general of two forward caterpillars, replacing the jack arm, and two rear caterpillars mounted under the rear end of the shovel.

The front caterpillars are so designed that they can swivel and adjust themselves to unevenness of the ground. Both front caterpillars are drivers.

The rear caterpillars consist of two caterpillar units mounted on the same frame. They are designed with sufficient strength to permit the crossing of holes and ditches without the delay incidental to filling in.

Steering is accomplished through the rear caterpillars. The steering arm is integral with the pintle of the rear caterpillar trucks. It carries a heavy gear segment, which engages a pinion on a vertical shaft. It is driven by an independent center valve, reverse type engine, suspended underneath the car frame. This engine may be operated either from the operator's stand or from ground alongside the rear caterpillars. Steering in curves of large diameter can be accomplished by the swinging of the boom without the steering mechanism.



Propelling is accomplished through the front caterpillars. Both caterpillars may be driven together or each one independently, forward or backward. The propelling speed is about half a mile per hour. The tractive power is sufficient to enable the shovel to climb with ease 15% to 20% grades.

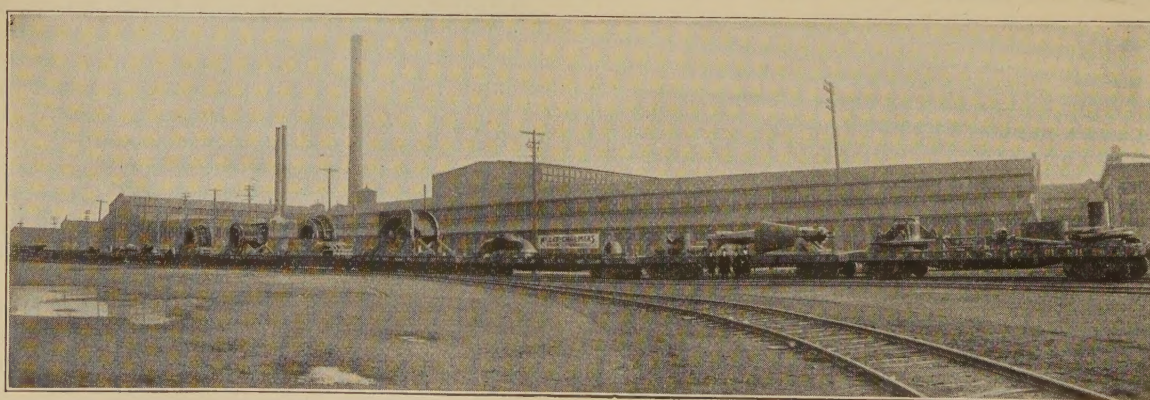
For transportation by rail, railroad trucks may be easily substituted.

Cement From Sea Mud

By IRWIN D. FOOS

Utilization of sea mud as a building material in southeastern France is reported by Consul W. W. Brunswick, at La Rochelle. Vast stretches of mud are uncovered at low tide along the coasts of the Charente-Inferieure Department, and recently, according to Consul Brunswick, a local contractor made an analysis of the mud and found that it contained silica, aluminum, limestone and oxide of iron, all elements in the manufacture of hydraulic cement, bricks, and blocks.

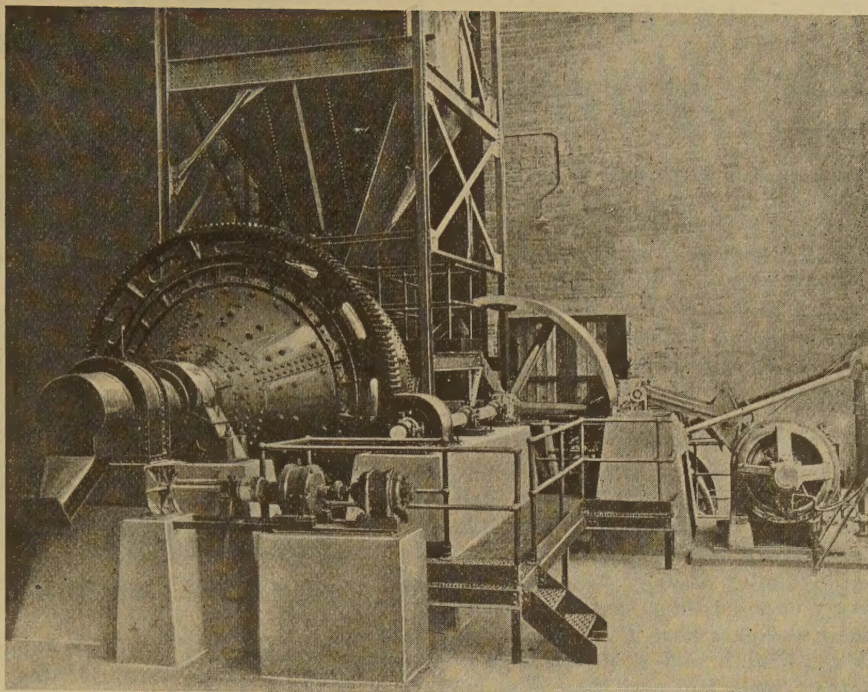
By the addition of fine sea mud it was shown that the swelling of the hydraulic lime or natural cement was reduced and the time of the initial and final set was prolonged, assuring the imperviousness of the product and increasing the resistance of the mixture. The sea mud has to undergo simple mechanical and thermic treatments before using.



Trainload of Crushers

The accompanying illustration shows a shipment of two No. 24 rock crushers, making an 11-car train, leaving the Allis-Chalmers com-

pany's plant. The weight of two crushers was 950,000 lbs., and the crushing capacity 10,000 tons in ten hours. This equipment was designed and built by Allis-Chalmers Mfg. Co. for Kelly Island Lime and Transport Co., Cleveland, O.



A 10 ft. dia. Ball Mill is Grinding Clinker

The largest ball mill ever built is now grinding an extremely hard clinker from kiln run to all through 20-mesh at an average rate of 142 barrels per hour. This is a 10-ft. diameter by 48-in. cylinder Hardinge Conical Ball Mill. Its ultimate capacity on average clinker is still to be determined, for the conditions under which it is now working are the most severe that could possibly be found.

When you consider that the feed to the mill often exceeds 4" and 5" in size, that the clinker is high in alumina and very low in lime, the capacity of 142 barrels per hour is truly remarkable.

Figure out for yourself how many grinding units you would save by installing this huge, slow-speed mill in your plant. It looks as though this size mill will become standard among large cement companies who favor large units when they can count on these units running continuously without fear of shutdowns for replacements and adjustments.

HARDINGE COMPANY
120 BROADWAY, NEW YORK, N.Y.
BRANCH OFFICES
WORKS: YORK, PENNA.; DENVER, COLO.; ERIE, PA.
SALT LAKE CITY, UTAH; NEWHOUSE BUILDING
LONDON, ENGLAND; 11 SOUTHAMPTON ROW
CABLE ADDRESS: HARDINGMIL, NEW YORK

Hardinge Conical Mills

Western Freight Rates in Scale Territory 3 Revised

By IRVIN D. FOOS

The Interstate Commerce Commission has been advised to revise the findings in its original report in western cement rates, and to provide for the application of an average of scales 2 and 3 rates between points in Nebraska, Kansas and Missouri, in Scale Territory 3, and also to provide rates in Scale Territory 4 not in excess of 120% of rates proposed for Scale 3 territory.

This means of effecting a compromise in the controversy on including eastern Nebraska and Kansas in Scale Territory 2 has been proposed by Examiner John T. Money. Rates and minimum weights on cement in carloads within Nebraska are found by Examiner Money to be lower than corresponding interstate rates and weight, and therefore unduly prejudicial to interstate shippers and discriminatory against interstate commerce.

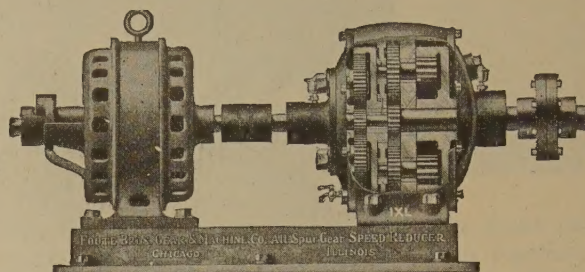
The Santa Fe and Burlington assumed the burden of the defense and strongly opposed the extension of Scale Territory 2 in Kansas and Nebraska. They urged that the general basis of rates south and west of the Missouri river is higher than north and east thereof. The record is persuasive, Examiner Money states, that Scale Territory 2 could not be extended into Kansas and Nebraska without including all of Scale Territory 3 south of the Platte River, including Hastings and Grand Island, Nebraska.

This would result in substantial reductions in the rates from not only the mills in the gas belt at Kansas City and Superior, the examiner states, but also from mills at St. Louis, Hannibal, and in Illinois and Iowa, which are not asking any reductions in rates to eastern Kansas and Nebraska. To apply Scale Territory 2 rates in Scale 3 territory also would necessitate such a substantial downward revision of the present rates in Scale Territory 4, applying from all mills including those in Colorado, according to Examiner Money, that it would be quite likely to necessitate a revision of the rates from Mason City, Iowa, and Steelton, Minn., to points in Scale Territories 3 and 4, in Minnesota and North Dakota.

The tentative report recommends that the Commission should find that the rates between points in Scale Territory 3 in Nebraska, Kansas and Missouri for the future will be unreasonable and unduly prejudicial to shippers between points in these states, and preferential of cement producing mills in Missouri, Illinois and Iowa to the extent that they exceed the rates based on an average of the present Scale 2 and Scale 3 rates, with the key-point rates from the Kansas gas belt to Kansas City, Omaha, Sioux City and St. Louis, observed as maxima at intermediate points over routes not over 115% of the short line routes. These rates should be based, it is urged, on the short line distances over routes not exceeding three lines where there are track connections, and be applied over all such lines not unreasonably circuitous. The Commission is advised to find further that the rates in present Scale Territory 4 in Kansas, Nebraska, South Dakota and Colorado, and in Wyoming and Montana, on the Burlington, should not exceed for the future by more than 20% the average of Scale 2 and Scale 3 rates.

The Dominion Iron and Steel Co., Ltd., has decided not to reopen its cement department this year. The plant, which the Dominion company has taken over, will be operated mainly to supply the cement requirements of the company.

FOOTE SPUR GEAR SPEED REDUCERS AND WORM GEAR REDUCERS



The Above Gear Ratio is 65 to 1.

ELIMINATE WASTEFUL METHODS

Foote Speed Transformers overcome the objections caused by open back gearing, chains and belts for speed reduction. They eliminate costly belt, gear and chain replacement, and prevent delayed production.

FOOTE DESIGN PROVIDES HIGHEST EFFICIENCY

Foote Speed Transformer design gives highest efficiency, compactness, durability and strength.

- Foote Speed Transformers are entirely enclosed, oil tight, dust proof and fool proof.

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